Document Number 3

Entry 3 of 13 File: USPT Jan 26, 1993

DOCUMENT-IDENTIFIER: US 5182230 A
TITLE: Laser methods for circuit repair on integrated circuits and substrates

BSPR:
Plating techniques have also been described wherein a metallic conductor was plated directly to a non-metallic substrate by immersing the substrate in a plating solution and heating the substrate in the region where deposition is desired. This heating could be accomplished in any number of ways, including exposure to a high intensity light through a mask or the use of a laser to selectively irradiate the surface of the substrate, causing the metallic plating material to deposit out in the irradiated region.

BSPR:
None of the cited references describes a means for locally accessing and repairing damaged conductors which have been subsequently covered by an insulating or passivation layer. Since most defects in semiconductor ICs are not discovered until after the IC is manufactured, the repair of semiconductor IC runs which are not accessible from the surface is a critical need. It would be extremely useful and cost effective to find a way of quickly and accurately repairing small breaks in IC conductor lines. In addition, it would be advantageous to accomplish such repairs without the necessity of a mask step. It would also be advantageous to accomplish such repairs by thermo-plating the region between the broken lines. It would further be advantageous to accomplish repair of such IC conductor lines without the necessity of depositing a conductive layer on the surface of the semiconductor substrate prior to thermo-deposition of the repair bridge.

DEPR:
FIG. 12 illustrates the actual plating of copper bridge 40. This plating may be accomplished by the methods previously described with reference to FIGS. 1 through 9. Plating may also be accomplished without using either the metal base of FIGS. 1 through 4 or the carbonaceous layer of FIGS. 5 through 9. In FIG. 12 bridge 40 is plated by placing substrate 30 into a copper sulfate bath, typically 0.1 to 1 molar with a similar concentration of sulfuric acid to produce the appropriate pH. Exposing substrate 30 to a focused laser such as an argon laser 18, with a power density on the order of 100 W/cm.sup.2 to 10 KW/cm.sup.2 in the region of discontinuity 9 causes the copper to plate directly to the conductor. Power densities on the order of 100 W/cm.sup.2 have been found to be effective when laser generated. However, such power densities are not limited to lasers and may be generated by other light sources. To bridge the circuit gap, the laser is repeatedly scanned between the two exposed line-ends 34a and 35a. The copper plates to the line-ends 34a and 35a until a bridge 40 is formed in the center of the defect 9. Simultaneous etching occurs which maintains charge neutrality at any cold or non-irradiated metal region which is in electrical contact with the area being bridged.

Document Number 7

Entry 7 of 13 File: USPT Jul 16, 1991

US-PAT-NO: 5032734
DOCUMENT-IDENTIFIER: US 5032734 A

TITLE: Method and apparatus for nondestructively measuring micro defects in materials

DATE-ISSUED: July 16, 1991

INT-CL: [5] G01N 21/01

US-CL-ISSUED: 250/572; 250/225

US-CL-CURRENT: 250/559.46; 250/225, 250/559.09, 250/559.16

FIELD-OF-SEARCH: 250/562, 250/563, 250/572, 250/225, 356/338, 356/340, 356/341, 356/368, 356/369, 356/370, 356/429-431, 356/445-449

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Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC

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Document Number 12

Entry 12 of 13 File: USPT Dec 21, 1982

DOCUMENT-IDENTIFIER: US 4364778 A
TITLE: Formation of multilayer dopant distributions in a semiconductor

BSPR:
Recently, the use of laser annealing has been widely studied. In this technique, a laser beam is used to raise the temperature of the semiconductor and thereby remove defects resulting from the ion implantation. Both solid state laser annealing and melting by means of a laser have been utilized to remove defects. Selective radiation by means of a laser can also be used to form devices in the doped layer. For example, a semiconductor body having an initial p-doping may be implanted with n-type dopant ions. A laser may be directed at the body to melt through the ion-implanted region into the underlying single crystal region. Upon resolidification of the melt, a p-n junction is typically obtained.

BSPR:
We have invented a method of obtaining multilayer dopant distributions in semiconductor material. In this method, a source of high intensity radiation is directed at a semiconductor body to produce brief melting at the surface. Included in the melt is both a high K and a low K dopant, wherein K is the equilibrium segregation coefficient. The difference in segregation of the dopants during freezing of the melt produces a junction in the resolidified region. Typical sources of radiation include lasers, electron beams, and ion beams. The high K dopant is introduced into, or deposited onto, the surface region that is to be melted. The low K dopant can also be deposited on, or introduced into, the surface region that is to be melted, or can be distributed throughout the semiconductor substrate, or a portion thereof. In any case, the melting extends into a single crystal region of the semiconductor body so that epitaxial regrowth occurs in at least a portion of the resolidified region. Typical dopant distributions produced include p-n, n-n+, and p-p+ junctions, metal-semiconductor junctions, bipolar transistors, MOS and junction field effect transistors, etc. An alloy or compound, typically a silicide, may also be obtained, most typically in the region having the low K dopant.

DEPR:
A p-type silicon wafer as in Example 1 was implanted with arsenic and thallium ions at an energy of 30 keV to produce an initial dopant distribution as shown in FIG. 15. The wafer was laser melted by overlapping laser spots each having a pulse power density of 28 MW/cm.sup.2, otherwise exactly as in Example 1. The resulting dopant distribution was determined by RBS, and is shown in FIG. 15. Mesa structures were then etched in the wafer, and the I-V characteristics determined. Two rectifying junctions were obtained: one within the resolidified region, and one at the interface between the bottom portion of the resolidified region and the unmelted single crystal wafer material. A structure similar to that shown in FIG. 10 (not to scale) was obtained, with the thallium (low K) dopant dominant in region 101, arsenic (high K) dopant dominant in region 102, and the bulk dopant of the wafer dominant in region 82.

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☐ 1. Document ID: US 5994913 A

Entry 1 of 58 File: USPT Nov 30, 1999

US-PAT-NO: 5994913
DOCUMENT-IDENTIFIER: US 5994913 A

TITLE: Method for analyzing defects in a semiconductor
DATE-ISSUED: November 30, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Lee; Nam Il	Kyoungkido	N/A	N/A	KRX

US-CL-CURRENT: 324/765; 324/158.1, 324/73.1

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 2. Document ID: US 5991699 A

Entry 2 of 58 File: USPT Nov 23, 1999

US-PAT-NO: 5991699
DOCUMENT-IDENTIFIER: US 5991699 A

TITLE: Detecting groups of defects in semiconductor feature space
DATE-ISSUED: November 23, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Kulkarni; Ashok V.	San Jose	CA	N/A	N/A
Rockwell; Paul	Santa Cruz	CA	N/A	N/A

US-CL-CURRENT: 702/83; 438/10, 438/12, 438/18, 702/35, 702/81, 702/82, 702/84

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 3. Document ID: US 5985497 A

Entry 3 of 58 File: USPT Nov 16, 1999

US-PAT-NO: 5985497
DOCUMENT-IDENTIFIER: US 5985497 A

TITLE: Method for reducing defects in a semiconductor lithographic process
DATE-ISSUED: November 16, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Phan; Khoi A.	San Jose	CA	N/A	N/A
Bains; Gurjeet S.	Yuba City	CA	N/A	N/A
Steele; David A.	Sunnyvale	CA	N/A	N/A
Orth; Jonathan A.	Essex Junction	VT	N/A	N/A
Subramanian; Ramkumar	San Jose	CA	N/A	N/A

US-CL-CURRENT: 430/30; 382/149

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

4. Document ID: US 5968264 A

Entry 4 of 58 File: USPT Oct 19, 1999

US-PAT-NO: 5968264
DOCUMENT-IDENTIFIER: US 5968264 A

TITLE: Method and apparatus for manufacturing a silicon single crystal having few crystal defects, and a silicon single crystal and silicon wafers manufactured by the same
DATE-ISSUED: October 19, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Iida; Makoto	Gunma-ken	N/A	N/A	JPX
Iino; Eiichi	Gunma-ken	N/A	N/A	JPX
Kimura; Masanori	Gunma-ken	N/A	N/A	JPX
Muraoka; Shozo	Gunma-ken	N/A	N/A	JPX
Yamanaka; Hideki	Fukushima-ken	N/A	N/A	JPX

US-CL-CURRENT: 117/30; 117/217, 117/218, 117/219, 117/222, 117/32, 117/917

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

5. Document ID: US 5967889 A

Entry 5 of 58 File: USPT Oct 19, 1999

US-PAT-NO: 5967889
DOCUMENT-IDENTIFIER: US 5967889 A

TITLE: Fixture for mechanical grinding and inspection of failed or defective semiconductor devices
DATE-ISSUED: October 19, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Tikhonov; Victor	San Antonio	TX	N/A	N/A

US-CL-CURRENT: 451/386; 29/557, 451/387, 451/391

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 6. Document ID: US 5948159 A
Entry 6 of 58 File: USPT Sep 7, 1999

US-PAT-NO: 5948159
DOCUMENT-IDENTIFIER: US 5948159 A

TITLE: Method of controlling defects of a silicon single crystal
DATE-ISSUED: September 7, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Nakamura; Kozo	Kanagawa	N/A	N/A	JPX
Saishoji; Toshiaki	Kanagawa	N/A	N/A	JPX
Kubota; Toshimichi	Kanagawa	N/A	N/A	JPX

US-CL-CURRENT: 117/13; 117/2, 117/20

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 7. Document ID: US 5945349 A
Entry 7 of 58 File: USPT Aug 31, 1999

US-PAT-NO: 5945349
DOCUMENT-IDENTIFIER: US 5945349 A

TITLE: Method of enabling analysis of defects of semiconductor device with three dimensions
DATE-ISSUED: August 31, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Koo; Jeong-Hoi	Seoul	N/A	N/A	KRX

US-CL-CURRENT: 438/694; 216/60, 216/85

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 8. Document ID: US 5943551 A
Entry 8 of 58 File: USPT Aug 24, 1999

US-PAT-NO: 5943551
DOCUMENT-IDENTIFIER: US 5943551 A

TITLE: Apparatus and method for detecting defects on silicon dies on a silicon wafer
DATE-ISSUED: August 24, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Schemmel; Floyd	Sherman	TX	N/A	N/A
Thorne; Richard	Sherman	TX	N/A	N/A

US-CL-CURRENT: 438/14; 438/16, 438/460

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 9. Document ID: US 5943437 A
Entry 9 of 58 File: USPT Aug 24, 1999

US-PAT-NO: 5943437
DOCUMENT-IDENTIFIER: US 5943437 A

TITLE: Method and apparatus for classifying a defect on a semiconductor wafer
DATE-ISSUED: August 24, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Sumie; Shingo	Kobe	N/A	N/A	JPX
Morimoto; Tsutomu	Kobe	N/A	N/A	JPX
Gotoh; Yuichiro	Kobe	N/A	N/A	JPX
Takahashi; Eiji	Kobe	N/A	N/A	JPX
Kanbe; Shouji	Hiranocho	N/A	N/A	JPX
Okamoto; Akira	Hiranocho	N/A	N/A	JPX

US-CL-CURRENT: 382/149; 382/145, 382/147

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

10. Document ID: US 5923430 A

Entry 10 of 58 File: USPT Jul 13, 1999

US-PAT-NO: 5923430
DOCUMENT-IDENTIFIER: US 5923430 A

TITLE: Method for characterizing defects on semiconductor wafers
DATE-ISSUED: July 13, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Worster; Bruce W.	Saratoga	CA	N/A	N/A
Lee; Ken K.	Los Altos	CA	N/A	N/A

US-CL-CURRENT: 356/394; 356/237.2, 356/448

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

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(defect$ near (semiconductor or silicon))[ti]	58

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☐ 11. Document ID: US 5902135 A
Entry 11 of 58 File: USPT May 11, 1999

US-PAT-NO: 5902135
DOCUMENT-IDENTIFIER: US 5902135 A

TITLE: Method for removing crystal defects in silicon wafers
DATE-ISSUED: May 11, 1999

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Schulze; Hans-Joachim	Ottobrunn	N/A	N/A	DEX

US-CL-CURRENT: 438/770; 438/556, 438/560, 438/787

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 12. Document ID: US 5840205 A
Entry 12 of 58 File: USPT Nov 24, 1998

US-PAT-NO: 5840205
DOCUMENT-IDENTIFIER: US 5840205 A

TITLE: Method of fabricating specimen for analyzing defects of semiconductor device
DATE-ISSUED: November 24, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Koo; Jeong-Hoi	Seoul	N/A	N/A	KRX
Park; Doo-Jin	Onyang	N/A	N/A	KRX

US-CL-CURRENT: 216/109; 216/53, 216/83, 216/95, 438/691, 438/745, 438/749, 438/750

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 13. Document ID: US 5831865 A
Entry 13 of 58 File: USPT Nov 3, 1998

US-PAT-NO: 5831865
DOCUMENT-IDENTIFIER: US 5831865 A

TITLE: Method and system for declusturing semiconductor defect data
DATE-ISSUED: November 3, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Berezin; Alan	Austin	TX	N/A	N/A
Quintanilla; Reuben	Austin	TX	N/A	N/A

US-CL-CURRENT: 395/500.08; 438/12, 700/110

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 14. Document ID: US 5837378 A
Entry 14 of 58 File: USPT Nov 17, 1998

US-PAT-NO: 5837378
DOCUMENT-IDENTIFIER: US 5837378 A

TITLE: Method of reducing stress-induced defects in silicon
DATE-ISSUED: November 17, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Mathews; Viju K.	Boise	ID	N/A	N/A
Jeng; Nanseng	Boise	ID	N/A	N/A
Fazan; Pierre C.	Boise	ID	N/A	N/A
Figura; Thomas A.	Boise	ID	N/A	N/A

US-CL-CURRENT: 438/439; 438/225, 438/297, 438/448

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 15. Document ID: US 5849642 A
Entry 15 of 58 File: USPT Dec 15, 1998

US-PAT-NO: 5849642
DOCUMENT-IDENTIFIER: US 5849642 A

TITLE: Method of fabricating specimen for exposing defects of a semiconductor device for observation and analysis
DATE-ISSUED: December 15, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Koo; Jeong-Hoi	Seoul	N/A	N/A	KRX
Park; Doo-Jin	Onyang	N/A	N/A	KRX

US-CL-CURRENT: 438/745; 216/83, 216/84

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 16. Document ID: US 5808735 A
Entry 16 of 58 File: USPT Sep 15, 1998

US-PAT-NO: 5808735
DOCUMENT-IDENTIFIER: US 5808735 A

TITLE: Method for characterizing defects on semiconductor wafers
DATE-ISSUED: September 15, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Lee; Ken K.	Los Altos	CA	N/A	N/A
Han; Ke	San Francisco	CA	N/A	N/A
Srinivasan; Lakshman	San Jose	CA	N/A	N/A
Worster; Bruce W.	Saratoga	CA	N/A	N/A

US-CL-CURRENT: 356/237.2; 250/559.42, 250/559.48, 356/369

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 17. Document ID: US 5798649 A
Entry 17 of 58 File: USPT Aug 25, 1998

US-PAT-NO: 5798649
DOCUMENT-IDENTIFIER: US 5798649 A

TITLE: Method for detecting defects in semiconductor insulators
DATE-ISSUED: August 25, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Smayling; Michael C.	Missouri City	TX	N/A	N/A
Anselm; Klaus A.	Houston	TX	N/A	N/A

US-CL-CURRENT: 324/551; 324/769, 438/17

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 18. Document ID: US 5766976 A
Entry 18 of 58 File: USPT Jun 16, 1998

US-PAT-NO: 5766976
DOCUMENT-IDENTIFIER: US 5766976 A

TITLE: Method for detecting crystal defects in a silicon single crystal substrate
DATE-ISSUED: June 16, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Majima; Masaki	Annaka	N/A	N/A	JPX

US-CL-CURRENT: 438/8; 216/84, 438/14

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 19. Document ID: US 5766695 A
Entry 19 of 58 File: USPT Jun 16, 1998

US-PAT-NO: 5766695
DOCUMENT-IDENTIFIER: US 5766695 A

TITLE: Method for reducing surface layer defects in semiconductor materials having a volatile species
DATE-ISSUED: June 16, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Nguyen; Chanh N.	Newbury Park	CA	N/A	N/A
Wilson; Robert G.	Winnetka	CA	N/A	N/A

US-CL-CURRENT: 427/553; 148/DIG.40, 427/523, 427/526, 438/514, 438/517, 438/918, 438/919

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

20. Document ID: US 5742175 A
Entry 20 of 58 File: USPT Apr 21, 1998

US-PAT-NO: 5742175
DOCUMENT-IDENTIFIER: US 5742175 A

TITLE: Method of evaluating a density of oxygen-precipitation defects in a silicon wafer
DATE-ISSUED: April 21, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Kato; Hirotaka	Hiratsuka	N/A	N/A	JPX
Matsumoto; Kei	Hiratsuka	N/A	N/A	JPX

US-CL-CURRENT: 324/765

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

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(defect$ near (semiconductor or silicon))[ti]	58

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21. Document ID: US 5649169 A
Entry 21 of 58 File: USPT Jul 15, 1997

US-PAT-NO: 5649169
DOCUMENT-IDENTIFIER: US 5649169 A

TITLE: Method and system for declustering semiconductor defect data
DATE-ISSUED: July 15, 1997

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Berezin; Alan	Austin	TX	N/A	N/A
Quintanilla; Reuben	Austin	TX	N/A	N/A

US-CL-CURRENT: 395/500.44; 700/110

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

22. Document ID: US 5648275 A
Entry 22 of 58 File: USPT Jul 15, 1997

US-PAT-NO: 5648275
DOCUMENT-IDENTIFIER: US 5648275 A

TITLE: Method for detecting defects in semiconductor insulators
DATE-ISSUED: July 15, 1997

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Smayling; Michael C.	Missouri City	TX	N/A	N/A
Anselm; Klaus A.	Austin	TX	N/A	N/A

US-CL-CURRENT: 438/18

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

23. Document ID: US 5598102 A
Entry 23 of 58 File: USPT Jan 28, 1997

US-PAT-NO: 5598102
DOCUMENT-IDENTIFIER: US 5598102 A

TITLE: Method for detecting defects in semiconductor insulators
DATE-ISSUED: January 28, 1997

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Smayling; Michael C.	Missouri City	TX	N/A	N/A
Anselm; Klaus A.	Houston	TX	N/A	N/A

US-CL-CURRENT: 324/537; 324/551, 324/765

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

24. Document ID: US 5548555 A

Entry 24 of 58 File: USPT Aug 20, 1996

US-PAT-NO: 5548555
DOCUMENT-IDENTIFIER: US 5548555 A

TITLE: Method and circuit for repairing defect in a semiconductor memory device
DATE-ISSUED: August 20, 1996

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Lee; Sung-Soo	Seoul	N/A	N/A	KRX
Kim; Jin-Ki	Seoul	N/A	N/A	KRX

US-CL-CURRENT: 365/200; 365/225.7, 365/230.03

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

25. Document ID: US 5539752 A

Entry 25 of 58 File: USPT Jul 23, 1996

US-PAT-NO: 5539752
DOCUMENT-IDENTIFIER: US 5539752 A

TITLE: Method and system for automated analysis of semiconductor defect data
DATE-ISSUED: July 23, 1996

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Berezin; Alan	Austin	TX	N/A	N/A
Quintanilla; Reuben	Austin	TX	N/A	N/A

US-CL-CURRENT: 714/724; 395/500.05, 395/500.2, 702/35

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

26. Document ID: US 5498871 A

Entry 26 of 58 File: USPT Mar 12, 1996

US-PAT-NO: 5498871
DOCUMENT-IDENTIFIER: US 5498871 A

TITLE: Method for analyzing the defectiveness of semiconductor device
DATE-ISSUED: March 12, 1996

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Koo; Jeong H.	Ichonkun	N/A	N/A	KRX
Kim; Chung T.	Ichonkun	N/A	N/A	KRX
Ju; Song K.	Ichonkun	N/A	N/A	KRX

US-CL-CURRENT: 250/307; 250/310

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

27. Document ID: US 5462883 A

Entry 27 of 58 File: USPT Oct 31, 1995

US-PAT-NO: 5462883
DOCUMENT-IDENTIFIER: US 5462883 A

TITLE: Method of fabricating defect-free silicon on an insulating substrate
DATE-ISSUED: October 31, 1995

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Dennard; Robert H.	Peekskill	NY	N/A	N/A
Meyerson; Bernard S.	Yorktown Heights	NY	N/A	N/A
Rosenberg; Robert	Peekskill	NY	N/A	N/A

US-CL-CURRENT: 438/459; 438/479, 438/970

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

28. Document ID: US 5452368 A

Entry 28 of 58 File: USPT Sep 19, 1995

US-PAT-NO: 5452368
DOCUMENT-IDENTIFIER: US 5452368 A

TITLE: Method of detecting defects in semiconductor package leads
DATE-ISSUED: September 19, 1995

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
LeBeau; Christopher J.	Tempe	AZ	N/A	N/A

US-CL-CURRENT: 382/145; 382/205

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

29. Document ID: US 5444265 A

Entry 29 of 58 File: USPT Aug 22, 1995

US-PAT-NO: 5444265
DOCUMENT-IDENTIFIER: US 5444265 A

TITLE: Method and apparatus for detecting defective semiconductor wafers during fabrication thereof
DATE-ISSUED: August 22, 1995

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Hamilton; Jeffrey L.	Livermore	CA	N/A	N/A

US-CL-CURRENT: 250/559.42; 250/559.29, 356/237.2

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 30. Document ID: US 5406085 A

Entry 30 of 58 File: USPT Apr 11, 1995

US-PAT-NO: 5406085
DOCUMENT-IDENTIFIER: US 5406085 A

TITLE: Apparatus and method for rapid and nondestructive determination of lattice defects in semiconductor materials
DATE-ISSUED: April 11, 1995

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Sharma; Suresh C.	Arlington	TX	N/A	N/A

US-CL-CURRENT: 250/358.1; 250/308

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

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☐ 31. Document ID: US 5271796 A

Entry 31 of 58 File: USPT Dec 21, 1993

US-PAT-NO: 5271796
DOCUMENT-IDENTIFIER: US 5271796 A

TITLE: Method and apparatus for detecting defect on semiconductor substrate surface
DATE-ISSUED: December 21, 1993

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Miyashita; Moriya	Yokohama	N/A	N/A	JPX
Kageyama; Mokuji	Yokohama	N/A	N/A	JPX
Hiratsuka; Hachiro	Yokohama	N/A	N/A	JPX

US-CL-CURRENT: 438/16; 156/345, 252/79.5

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 32. Document ID: US 5233203 A

Entry 32 of 58 File: USPT Aug 3, 1993

US-PAT-NO: 5233203
DOCUMENT-IDENTIFIER: US 5233203 A

TITLE: Apparatus for detecting surface defects on a semiconductor wafer
DATE-ISSUED: August 3, 1993

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Haga; Sachiko	Yamagata	N/A	N/A	JPX

US-CL-CURRENT: 250/559.41; 356/237.3

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 33. Document ID: US 5134446 A

Entry 33 of 58 File: USPT Jul 28, 1992

US-PAT-NO: 5134446
DOCUMENT-IDENTIFIER: US 5134446 A

TITLE: Semiconductor device having a buffer structure for eliminating defects from a semiconductor layer grown thereon
DATE-ISSUED: July 28, 1992

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Inoue; Toshikazu	Kawasaki	N/A	N/A	JPX

US-CL-CURRENT: 257/190; 257/197

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

34. Document ID: US 5133160 A
Entry 34 of 58 File: USPT Jul 28, 1992

US-PAT-NO: 5133160
DOCUMENT-IDENTIFIER: US 5133160 A

TITLE: Process for the removal of specific crystal structures defects from semiconductor discs
DATE-ISSUED: July 28, 1992

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Lampert; Ingolf	Burghausen	N/A	N/A	DEX
Wahlich; Reinhold	Burghausen	N/A	N/A	DEX

US-CL-CURRENT: 451/36; 148/240, 438/472, 438/959, 451/113, 451/59, 451/78, 72/53

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

35. Document ID: US 5062715 A
Entry 35 of 58 File: USPT Nov 5, 1991

US-PAT-NO: 5062715
DOCUMENT-IDENTIFIER: US 5062715 A

TITLE: Method and apparatus for detecting photoacoustic signal and method for detecting internal defect of semiconductor device
DATE-ISSUED: November 5, 1991

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Nakata; Toshihiko	Yokohama	N/A	N/A	JPX
Kembo; Yukio	Yokohama	N/A	N/A	JPX

US-CL-CURRENT: 356/432

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

36. Document ID: US 4962051 A
Entry 36 of 58 File: USPT Oct 9, 1990

US-PAT-NO: 4962051
DOCUMENT-IDENTIFIER: US 4962051 A

TITLE: Method of forming a defect-free semiconductor layer on insulator
DATE-ISSUED: October 9, 1990

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Liaw; H. Ming	Scottsdale	AZ	N/A	N/A

US-CL-CURRENT: 438/474; 148/33.3, 148/DIG.40, 148/DIG.59, 148/DIG.72, 148/DIG.97, 438/480, 438/766

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

37. Document ID: US 4885056 A
Entry 37 of 58 File: USPT Dec 5, 1989

US-PAT-NO: 4885056
DOCUMENT-IDENTIFIER: US 4885056 A

TITLE: Method of reducing defects on semiconductor wafers
DATE-ISSUED: December 5, 1989

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Hall; James B.	Chandler	AZ	N/A	N/A
Sheff; Sumner	Scottsdale	AZ	N/A	N/A

US-CL-CURRENT: 438/691; 252/79.2, 252/79.3, 438/753

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

38. Document ID: US 4862000 A
Entry 38 of 58 File: USPT Aug 29, 1989

US-PAT-NO: 4862000
DOCUMENT-IDENTIFIER: US 4862000 A

TITLE: Method for predicting density of micro crystal defects in semiconductor element from silicon wafer used in the manufacture of the element, and infrared absorption measurement apparatus for this method
DATE-ISSUED: August 29, 1989

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Kubota; Atsuko	Yokohama	N/A	N/A	JPX
Matsushita; Yoshiaki	Kawasaki	N/A	N/A	JPX
Ohwada; Yoshiaki	Yokohama	N/A	N/A	JPX

US-CL-CURRENT: 250/339.03; 250/339.08, 250/339.12, 250/341.4

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

39. Document ID: US 4803884 A
Entry 39 of 58 File: USPT Feb 14, 1989

US-PAT-NO: 4803884
DOCUMENT-IDENTIFIER: US 4803884 A

TITLE: Method for measuring lattice defects in semiconductor
DATE-ISSUED: February 14, 1989

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Kaneta; Hiroshi	Kawasaki	N/A	N/A	JPX
Ogawa; Tsutomu	Machida	N/A	N/A	JPX
Mori; Haruhisa	Yokohama	N/A	N/A	JPX
Wada; Kunihiko	Kawasaki	N/A	N/A	JPX

US-CL-CURRENT: 73/598; 374/117, 73/597

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

40. Document ID: US 4801869 A
Entry 40 of 58 File: USPT

US-PAT-NO: 4801869
DOCUMENT-IDENTIFIER: US 4801869 A

TITLE: Semiconductor defect monitor for diagnosing processing-induced defects

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Sprogis; Edmund J.	Jericho	VT	N/A	N/A

US-CL-CURRENT: 714/733; 324/765, 365/201

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

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41. Document ID: US 4772933 A

Entry 41 of 58 File: USPT Sep 20, 1988

US-PAT-NO: 4772933
DOCUMENT-IDENTIFIER: US 4772933 A

TITLE: Method for compensating operationally-induced defects and semiconductor device made thereby
DATE-ISSUED: September 20, 1988

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY	
Schade; Horst E. P.	Montgomery Township, Somerset	NJ	N/A	N/A	County

US-CL-CURRENT: 257/610; 136/258, 257/458, 257/53

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

42. Document ID: US 4741212 A

Entry 42 of 58 File: USPT May 3, 1988

US-PAT-NO: 4741212
DOCUMENT-IDENTIFIER: US 4741212 A

TITLE: Method for determining structural defects in semiconductor wafers by ultrasonic microscopy
DATE-ISSUED: May 3, 1988

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Rehwald; Walther	Wettingen	N/A	N/A	CHX

US-CL-CURRENT: 73/600; 73/618

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

43. Document ID: US 4725558 A

Entry 43 of 58 File: USPT Feb 16, 1988

US-PAT-NO: 4725558
DOCUMENT-IDENTIFIER: US 4725558 A

TITLE: Semiconductor defects curing method and apparatus
DATE-ISSUED: February 16, 1988

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Yamazaki; Shunpei	Tokyo	N/A	N/A	JPX
Suzuki; Kunio	Atsugi	N/A	N/A	JPX
Kinka; Mikio	Atsugi	N/A	N/A	JPX
Fukada; Takeshi	Ebina	N/A	N/A	JPX
Abe; Masayoshi	Tokyo	N/A	N/A	JPX
Kobayashi; Ippei	Atsugi	N/A	N/A	JPX
Shibata; Katsuhiko	Atsugi	N/A	N/A	JPX
Susukida; Masato	Atsugi	N/A	N/A	JPX
Nagayama; Susumu	Tokyo	N/A	N/A	JPX
Koyanagi; Kaoru	Saku	N/A	N/A	JPX

US-CL-CURRENT: 438/80; 136/244, 136/258, 136/290, 438/4, 438/466, 438/88

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

44. Document ID: US 4680616 A

Entry 44 of 58 File: USPT Jul 14, 1987

US-PAT-NO: 4680616
DOCUMENT-IDENTIFIER: US 4680616 A

TITLE: Removal of defects from semiconductors
DATE-ISSUED: July 14, 1987

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Delahoy; Alan E.	Rocky Hill	NJ	N/A	N/A
Tonon; Thomas	Princeton	NJ	N/A	N/A

US-CL-CURRENT: 257/62; 136/244, 136/249, 136/258, 136/290, 257/458, 257/56, 257/798, 438/4, 438/466, 438/798, 438/88

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

45. Document ID: US 4652757 A

Entry 45 of 58 File: USPT Mar 24, 1987

US-PAT-NO: 4652757
DOCUMENT-IDENTIFIER: US 4652757 A

TITLE: Method and apparatus for optically determining defects in a semiconductor material
DATE-ISSUED: March 24, 1987

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Carver; Gary E.	Raritan Township, Hunterdon County	NJ	N/A	N/A

US-CL-CURRENT: 250/360.1; 250/338.1, 250/341.4, 250/358.1, 356/432

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

46. Document ID: US 4514830 A
Entry 46 of 58 File: USPT Apr 30, 1985

US-PAT-NO: 4514830
DOCUMENT-IDENTIFIER: US 4514830 A

TITLE: Defect-remediable semiconductor integrated circuit memory and spare substitution method in the same
DATE-ISSUED: April 30, 1985

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Hagiwara; Takaaki	Kodaira	N/A	N/A	JPX
Horiuchi; Masatada	Koganei	N/A	N/A	JPX
Kondo; Ryuji	Kodaira	N/A	N/A	JPX
Yatsuda; Yuji	Kanagawa	N/A	N/A	JPX
Minami; Shinichi	Hachioji	N/A	N/A	JPX

US-CL-CURRENT: 365/185.09; 365/210

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

47. Document ID: US 4420497 A
Entry 47 of 58 File: USPT Dec 13, 1983

US-PAT-NO: 4420497
DOCUMENT-IDENTIFIER: US 4420497 A

TITLE: Method of detecting and repairing latent defects in a semiconductor dielectric layer
DATE-ISSUED: December 13, 1983

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Tickle; Andrew C.	Los Altos	CA	N/A	N/A

US-CL-CURRENT: 438/466; 205/766, 427/140, 427/8, 438/4, 438/762, 438/763, 438/770, 438/775

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

48. Document ID: US 4415373 A
Entry 48 of 58 File: USPT Nov 15, 1983

US-PAT-NO: 4415373
DOCUMENT-IDENTIFIER: US 4415373 A

TITLE: Laser process for gettering defects in semiconductor devices
DATE-ISSUED: November 15, 1983

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Pressley; Robert J.	Cupertino	CA	N/A	N/A

US-CL-CURRENT: 438/473; 148/DIG.93, 257/609, 257/612, 427/554, 438/476

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

49. Document ID: US 4400232 A

Entry 49 of 58 File: USPT Aug 23, 1983

US-PAT-NO: 4400232
DOCUMENT-IDENTIFIER: US 4400232 A

TITLE: Control of oxygen- and carbon-related crystal defects in silicon processing
DATE-ISSUED: August 23, 1983

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Ownby; Paul D.	Rolla	MO	N/A	N/A
Grayson; Paul E.	Joplin	MO	N/A	N/A

US-CL-CURRENT: 117/15; 117/900, 117/916, 117/932, 423/350

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

50. Document ID: US 4332627 A

Entry 50 of 58 File: USPT Jun 1, 1982

US-PAT-NO: 4332627
DOCUMENT-IDENTIFIER: US 4332627 A

TITLE: Method of eliminating lattice defects in a semiconductor device
DATE-ISSUED: June 1, 1982

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Schmitt; Alfred	Boeblingen	N/A	N/A	DEX
Schorer; Gerd	Herrenberg	N/A	N/A	DEX

US-CL-CURRENT: 438/527; 257/558, 257/607, 438/373, 438/530

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

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☐ 51. Document ID: US 4316765 A
Entry 51 of 58 File: USPT Feb 23, 1982

US-PAT-NO: 4316765
DOCUMENT-IDENTIFIER: US 4316765 A

TITLE: Detection of defects in semiconductor materials
DATE-ISSUED: February 23, 1982

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Thiel; Ferdinand A.	South Plainfield	NJ	N/A	N/A

US-CL-CURRENT: 438/8; 252/79.2, 436/5, 438/16, 438/745

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 52. Document ID: US 4243473 A
Entry 52 of 58 File: USPT Jan 6, 1981

US-PAT-NO: 4243473
DOCUMENT-IDENTIFIER: US 4243473 A

TITLE: Method for detecting crystal defects in semiconductor silicon and detecting solution therefor
DATE-ISSUED: January 6, 1981

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Yamaguchi; Hisayoshi	Annaka	N/A	N/A	JPX
Kuroyanagi; Itsuo	Annaka	N/A	N/A	JPX

US-CL-CURRENT: 438/16; 356/30, 436/4, 438/750

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 53. Document ID: US 4238694 A
Entry 53 of 58 File: USPT Dec 9, 1980

US-PAT-NO: 4238694
DOCUMENT-IDENTIFIER: US 4238694 A

TITLE: Healing radiation defects in semiconductors
DATE-ISSUED: December 9, 1980

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Kimerling; Lionel C.	Westfield	NJ	N/A	N/A
Leamy; Harry J.	New Providence	NJ	N/A	N/A
Smith; George E.	Murray Hill	NJ	N/A	N/A

US-CL-CURRENT: 326/38; 148/DIG.46, 148/DIG.55, 148/DIG.93, 257/289, 257/530, 257/617 , 326/102, 326/41, 326/44, 327/566, 438/130, 438/292, 438/308, 438/466

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 54. Document ID: US 4180439 A
Entry 54 of 58 File: USPT Dec 25, 1979

US-PAT-NO: 4180439
DOCUMENT-IDENTIFIER: US 4180439 A

TITLE: Anodic etching method for the detection of electrically active defects in silicon
DATE-ISSUED: December 25, 1979

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Deines; John L.	Pleasant Valley	NY	N/A	N/A
Poponiak; Michael R.	Newburgh	NY	N/A	N/A
Schwenker; Robert O.	Hopewell Junction	NY	N/A	N/A

US-CL-CURRENT: 205/791; 205/656, 205/791.5

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 55. Document ID: US 4149915 A
Entry 55 of 58 File: USPT Apr 17, 1979

US-PAT-NO: 4149915
DOCUMENT-IDENTIFIER: US 4149915 A

TITLE: Process for producing defect-free semiconductor devices having overlapping high conductivity impurity regions
DATE-ISSUED: April 17, 1979

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Bohg; Armin	Neuweiler	N/A	N/A	DEX
Magdo; Ingrid E.	Hopewell Junction	NY	N/A	N/A

US-CL-CURRENT: 438/545; 148/DIG.61, 257/517, 257/519, 257/586, 257/623, 257/648, 438/363, 438/563, 438/568

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 56. Document ID: US 4042419 A
Entry 56 of 58 File: USPT Aug 16, 1977

US-PAT-NO: 4042419
DOCUMENT-IDENTIFIER: US 4042419 A

TITLE: Process for the removal of specific crystal structure defects from semiconductor discs and the product thereof
DATE-ISSUED: August 16, 1977

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Heinke; Wolfgang	Mehring-Oed	N/A	N/A	DT
Kirschner; Helmut	Burghausen	N/A	N/A	DT
Reimann; Detlef	Engelsberg	N/A	N/A	DT

US-CL-CURRENT: 438/471; 148/33, 148/DIG.61, 438/476, 451/53

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 57. Document ID: US 3737282 A

Entry 57 of 58 File: USPT Jun 5, 1973

US-PAT-NO: 3737282
DOCUMENT-IDENTIFIER: US 3737282 A

TITLE: METHOD FOR REDUCING CRYSTALLOGRAPHIC DEFECTS IN SEMICONDUCTOR STRUCTURES
DATE-ISSUED: June 5, 1973

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Hearn; Eric W.	Wappingers Falls	NY	12590	N/A
Schwuttke; Guenter H.	Poughkeepsie	NY	12603	N/A
Tekaat; Erich H.	Fishkill	NY	12524	N/A

US-CL-CURRENT: 438/795; 118/500, 414/940, 432/11, 432/253, 432/6

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

☐ 58. Document ID: US 3569699 A

Entry 58 of 58 File: USPT Mar 9, 1971

US-PAT-NO: 3569699
DOCUMENT-IDENTIFIER: US 3569699 A

TITLE: A DEVICE FOR DETECTING CRYSTALLOGRAPHIC DEFECTS IN SEMICONDUCTOR CRYSTALS
DATE-ISSUED: March 9, 1971

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Cielecki; Andrzej	Warsaw	N/A	N/A	PO

US-CL-CURRENT: 250/360.1; 250/370.01, 250/492.2

Full | Title | Citation | Front | Review | Classification | Date | Reference | Claims | KWIC | Image

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Document Number 13

Entry 13 of 13 File: USPT Feb 16, 1982

DOCUMENT-IDENTIFIER: US 4316074 A
TITLE: Method and apparatus for laser irradiating semiconductor material

ABPL:
A laser system is disclosed for facilitating transient surface heating and/or melting and regrowth of amorphous, polycrystalline or imperfect crystalline semiconductor wafer material. This system also has specific application to gettering of impurities and the annealing-out of defects within a semiconductor wafer. In the system, a number of circular target-wafers are arranged around the periphery of a turntable. The turntable rotates while a simple, slow-moving beam-delivery system moves radially with respect to the turntable delivering a helical scan which may also be in the form of a multiple-track. Use of the turntable with a multiple wafer load allows efficient batch-processing. Blocking masks may be employed when it is desired to irradiate only selected areas of the semiconductor substrates.

BSPR:
Recently an alternative technique for ion-implantation annealing has been investigated. This technique utilizes high-intensity laser radiation to provide surface heating of implanted wafers thereby permitting localized annealing in very short time periods; it has been termed laser ion implantation annealing. As a result of the extremely short irradiation times (typically fractions of a microsecond), the problems of dopant migration, contamination and lifetime reduction may be greatly reduced by this technique.

BSPR:
If the laser beam diameter is large compared to the thermal depth, .delta.,(.delta.=[k.tau.].sup.1/2, where k is the thermal diffusivity and .tau. the pulse width) then the heat flow may be treated as a one-dimensional problem. The resulting temperature distribution can be obtained using the procedures of Carslaw and Jaeger. H. S. Carslaw and J. C. Jaeger "Conduction of Heat in Solids" Oxford University Press, 1959. ##EQU2## where K is the thermal conductivity. At the surface ##EQU3## The normalized temperature .THETA.=(KT)/I.sub.o .GAMMA.) is plotted in FIG. 7; over a large range of .alpha..delta. the function can be approximated by [1-exp(-.alpha..delta.)], so that ##EQU4## For a typical value of .alpha..delta..about.1 the temperature is approximately 0.6I.sub.o .delta./K. Using values for silicon, the calculated threshold to heat the surface to the melting point, T.sub.m, therefore is ##EQU5## where .delta.=.sqroot.kt =(0.075.times.1.35.times.10.sup.-7)1/2.apprxeq.10.sup.-4 Since the reflectivity is 30%, the required incident power density is 4.3.times.10.sup.6 watts/cm.sup.2 and the threshold energy density, E.sub.t =(I.sub.o T/(R), is 0.6 J/cm.sup.2 ; this is in close agreement with measured values of about 1 J/cm.sup.2. The difference is due to the fact that it is necessary to melt to a depth of about 1 micrometer and to supply the heat of fusion, as will be calculated next.

BSPV:
I.sub.o is the effective surface power density.

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Document Number 98

Entry 98 of 111 File: USPT Apr 23, 1985

DOCUMENT-IDENTIFIER: US 4512197 A
TITLE: Apparatus for generating a focusable and scannable ultrasonic beam for non-destructive examination

BSPR:
This invention relates generally to ultrasonic examination of opaque materials, and more particularly to small ultrasonic beams which are both focusable and scannable so as to be suitable for detecting small defects.

BSPR:
An important application of ultrasonics is examining opaque materials and tissue for internal flaws and abnormalities. The examination of materials for flaw detection as well as the examination of tissue for medical diagnostic purposes are improved by the use of small acoustic beams which can be scanned and focused. Such small acoustic beams are desirable in order to detect small defects.

BSPR:
A major drawback to these methods is that the ultrasonic beam is not focusable or scannable, thus small defects are difficult, if not impossible to detect.

DEPR:
Generation of the ultrasonic waves is based on the fact that when a pulse of energy is rapidly delivered onto the surface of certain materials in contact with an acoustic medium there is a rapid thermal expansion of the surface. This rapid expansion produces a nonequilibrium stress distribution which results in a stress wave being propagated through the material and transmitted through the acoustic medium. By generating laser pulses of sufficiently long duration, for example greater than 0.1 .mu.sec, and sufficiently high power density, approximately 10.sup.6 peak watts/cm.sup.2, it is possible to generate detectable ultrasonic pulses in the megahertz frequency range without any substantial material damage.

DEPR:
Some of the many advantages and new features of the subject invention should now be apparent in view of the foregoing description. For example, an ultrasonic beam having a wavelength which is sufficiently small to detect small defects and abnormalities in a sample can be generated. Moreover, this ultrasonic beam may be quickly and easily focused and scanned over the sample without the need for bulky or expensive equipment.

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Document Number 104

Entry 104 of 111 File: USPT Jan 27, 1981

DOCUMENT-IDENTIFIER: US 4246793 A
TITLE: Nondestructive testing

BSPR:
A major problem encountered in the steel industry is the inability to nondestructively interrogate hot steel billets to detect internal defect structures before cooling. The present technique can detect defect structures in hot steel.

DEPR:
Initiation of a blast wave in the gas environment adjacent to the material surface is caused by a source of priming electrons. Below the laser power density threshold for initiation of a blast wave most of the laser radiation incident on the surface is reflected. When the threshold power density is reached, the intensity of the electric field associated with the laser light radiation is sufficient strong in the vicinity of the material surface to generate free electrons in the gas or at the material surface due to field emission. The electric fields are enhanced near the target surface because of constructive interference between the incident and reflected electromagnetic waves. Surface defect enhanced fields are expected to lower the laser power density threshold for production of free electrons compared to a theoretically perfect surface.

DEPR:
The first experiments were designed to demonstrate that laser induced ultrasonic signals can be propagated and detected through thick steel specimens at temperatures ranging from the standard room value to a value in excess of the austenizing temperature where nondestructive evaluation of steel is desired. The 4.5 cm thick cold rolled steel block 11 was heated and then manually removed to a stand where the laser beam 14' was directed to one surface 28 of the steel block 11, which was in an air environment at normal room conditions. An electromagnetic transducer 22 with a 32 turn copper coil 40 and a permanent magnet 41, providing a static magnetic field of 1.53 kilogauss, was placed near the opposite surface 12 to detect the transmitted ultrasonic signal. A one meter focal length germanium lens 31 was used to focus the laser beam 14' down to various spot sizes at the region 13' at the metal surface 28. No detectable signals were observed until the incident laser power density exceeded about 2.times.10.sup.7 W/cm.sup.2. The laser beam 14' was subsequently focused down to a spot size at the region 13' of approximately 0.24 cm.sup.2 (about 0.6 cm diameter) which resulted in a laser energy density at the metal surface 28 of about 40 J/cm.sup.2 (1.6.times.10.sup.8 W/cm.sup.2).

DEPR:
A set of experiments were performed to demonstrate that a defect can be detected in a hot steel block. The temperature was 787 C. The laser beam 14 was directed to the same surface 12 where the electromagnetic transducer 22 was located in order to utilize a pulse echo technique to detect the signal reflected from the back surface 28 and the defect 33. The germanium lens 21 was adjusted to give a laser energy density of

approximately 45 J/cm.sup.2 (1.8.times.10.sup.8 W/cm.sup.2) at the region 13 at the steel surface 12.

DEPR:
Time discrimination schemes are easily incorporated into the present method of detecting defects in high temperature materials. For example, consider the case where the laser beam is split into two components 14, 14' and these components are directed to the two opposite surfaces 12, 28 of the part being interrogated as shown in FIG. 1. The transducers 22, 23 will each see three signals, one due to scatter off the defect 33; one due to reflection off the opposite surface 28 or 12; and one due to the source of sound transmitted from the other surface. If V.sub.s is the speed of sound in the material being interrogated, D is the thickness of the body 11, and x is the distance from the surface 12 to the defect 33, one transducer will see signals at times ##EQU1## and the other will see signals at ##EQU2##

DEPR:
Several experiments were conducted later concerning effects of laser power density and energy density in generating ultrasonic waves.

DEPR:
In the case of the TEA-CO.sub.2 experiments, the laser spot size at the region 13 was maintained at about 0.34 square centimeters and the intensity was varied by inserting various attenuators (not shown) in the beam 14. Several measurements were made. The amplitude of the signal reflected off the back surface 28 is given in Table I, below, as a function of the incident laser energy density (J/cm.sup.2). These numbers are converted to laser power density (W/cm.sup.2) by dividing the J/cm.sup.2 by the laser pulse width. These numbers also are given in the last five lines in Table I. All measurements were made at about 685 C.

DEPR:
These data are plotted as circles in FIG. 7. The important point to be noted from these data is that the acoustic signals increase significantly with increased energy density, and with increased power density at a given pulse width, over the measured ranges. As is seen from the earlier examples, the acoustic signals also will rapidly fall to approximately a zero value as the laser energy density is decreased. This is because almost all of the 10.6 .mu.m CO.sub.2 laser radiation will be reflected from the metal surface when the laser energy density is decreased below the threshold for initiation of a blast wave.

DEPR:
The amplitude of the detected signal is a function of the laser spot size because this parameter determines the size of the ultrasonic source. The ultrasonic signal that propagates into the steel is highly directional. Therefore, the amount of ultrasonic energy reflected off a defect or surface and captured by a detector is a function of the diameter of the beam of ultrasound that propagates through the material.

DEPR:
Some experiments conducted still later show that the threshold condition for initiation of a blast wave is defined most conveniently in terms of the laser energy density (J/cm.sup.2) incident on the surface of the material being interrogated. This quantity is the product of the laser power density and the effective or equivalent duration of the laser pulse (FWHM). At a laser wavelength of 10.6 .mu.m the laser energy density required to initiate a blast wave is about 5 J/cm.sup.2. At 1.06 .mu.m it is about 50 J/cm.sup.2.

DEPR:
The shapes of the curves depicting signal amplitude versus laser energy density are different at 1.06 .mu.m (FIG. 8) and at 10.6 .mu.m (FIG. 7) because the curve at the shorter wavelength is caused by two effects, namely laser induced surface vaporization and initiation of a blast wave. As one proceeds to longer wavelength, surface vaporization will

eventually cease (probably at about 3 to 7 .mu.m). This is the case for the 10.6 .mu.m signals. The laser powder density threshold for initiation of vaporization at 1.06 .mu.m and laser pulse widths between 111 nanoseconds and 21.6 nanoseconds ranges from about 107 W/cm.sup.2 up to about 10.sup.8 W/cm.sup.2. The laser energy density equivalent to this range of power densities is about 1 J/cm.sup.2 up to a few J/cm.sup.2. On the other hand, the threshold laser energy density for initiation of the blast wave is about 50 J/cm.sup.2.